A New Breed of Innovative Ground Water Modeling

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Under-sampled measurements are an obstacle in every ground water remediation project. They necessitate nonunique interpolations that can distort the distribution of essential physical properties (e.g., contaminant distributions, permeability, and porosity), which largely determine the contaminant migration rates and paths from sources to receptor locations. We use coupled forward and inverse modeling to resolve this problem because it provides the only way to obtain constitutive property distributions that simultaneously simulate the flow and transport behavior observed in borehole measurements.

New modeling concepts and software have recently emerged from two decades of research on self-adaptive partial differential equation (PDE) solvers. We report results of testing a revolutionary software product, *PDEase*, in applications to coupled forward and inverse flow problems in the Superfund cleanup effort at Lawrence Livermore National Laboratory's (LLNL) Livermore Site.

The new *PDEase* modeling enables users to provide the flow equations, site geometry, sources, sinks, constitutive parameters, and boundary conditions to the software. Its symbolic processors then construct the actual numerical solution code and solve it automatically. Powerful grid refinements that conform adaptively to evolving flow features are executed dynamically with iterative finite element solutions that minimize numerical errors to user-specified limits. Convergence of the numerical solutions can be tested easily with the diagnostic information, and interactive graphical displays that appear as the solutions are generated.

LLNL ground water flow code verification examples and validations will be presented and compared to results from the standard industry codes, MODFLOW/MODINV, for coupled forward and inverse problems.

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